

11/06/00

Case Docket No.: TP-9809 Div.

Assistant Commissioner For Patents
Washington, D.C. 20231

JJC 946 U.S. PTO
09/07/105
11/06/00

Sir:

Transmitted herewith for filing under the provisions of 37 CFR 1.52 is the patent application of:

Inventor: Jonathan L. Rolfe et al.
For: A DISPOSABLE HYDROGEN FUEL SOURCE

Enclosed are:

5 sheets of drawings.
 An assignment of the invention to: _____
 A verified statement to establish small entity status.
 A copy of the previous Declaration And Power Of Attorney filed in parent case Serial No. 09/309,198.

The filing fee has been calculated as shown below:

			Small Entity		Large Entity	
For:	No. Filed	No. Extra	Rate	Fee	Rate	Fee
Basic Fee				\$355.00		\$710.00
Total Claims	22 - 20	2	x \$ 9.00		x \$18.00	36.00
Ind. Claims	6 - 3	3	x \$40.00		x \$80.00	240.00
Mult. Claims			+ \$135.00		+ \$270.00	
				Total	Total	\$ 986.00

Please charge my Deposit Account No. 16-0221 to cover the filing fee and assignment recording fee. A duplicate copy of this sheet is enclosed.

A check in the amount of \$986.00 to cover the filing fee (and the assignment recording fee) is enclosed.

The Commissioner is hereby authorized to charge payment of the following fees associated with this communication or credit any overpayment to Deposit Account No. 16-0221. A duplicate copy of this sheet is enclosed.

Any additional filing fees required under 37 CFR 1.16.

Any patent application processing fees under 37 CFR 1.17.

The Commissioner is hereby authorized to charge payment of the following fees during the pendency of this application or credit any overpayment to Deposit Account No. 16-0221. A duplicate copy of this sheet is enclosed.

Any patent application processing fees under 37 CFR 1.17.

The issue fee set in 37 CFR 1.18 at or before mailing of the Notice of Allowance, pursuant to 37 CFR 1.311(b).

Any filing fees under 37 CFR 1.16 for presentation of extra claims.

Respectfully submitted,

Matthew Lester

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Jonathan L. Rolfe et al.
For: A DISPOSABLE HYDROGEN FUEL SOURCE
Attorney's Docket No.: TP-9809 Div.

BOX PATENT APPLICATION
Assistant Commissioner For Patents
Washington, D.C. 20231

Sir:

FILING OF PATENT APPLICATION UNDER 37 CFR 1.10

The attached application is being filed under the provisions of 37 CFR 1.10.

Applicants' attorney is also submitting the requisite fee as calculated on the attached transmittal letter.

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Scott R. Foster

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Respectfully submitted,



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2

3 A DISPOSABLE HYDROGEN FUEL SOURCE4 CROSS-REFERENCE TO RELATED APPLICATION5 This is a division of application serial No. 09/309,198,
6 filed May 10, 1999, in the names of Jonathan L. Rolfe et al.

7

8 STATEMENT OF GOVERNMENT INTEREST9 This invention was made with Government support under
10 Cooperative Agreement No. DE-FC02-97EE 50483 awarded by the
11 Department of Energy. The Government has certain rights in this
12 invention.

13

14 BACKGROUND OF THE INVENTION

15 1. Field of the Invention

16 The invention relates to disposable hydrogen fuel sources and
17 is directed more particularly to a device which produces hydrogen
18 for use in fuel cells, and the like, at a selected pressure,
19 automatically and continuously, until exhausted.

20

21 2. Description of the Prior Art

22 It is known to provide a small hydrogen generator for
23 providing hydrogen for fuel cells, the hydrogen being generated by
24 reacting a metal hydride with water or water vapor. In U.S.
25 Patent No. 4,155,712, issued May 22, 1979, to Walter G. Taschek,

1 there is disclosed a hydrogen generator for providing hydrogen on
2 demand to a fuel cell.

3 Taschek provides a first compartment containing a metal
4 hydride, such as lithium aluminum hydride (LiAlH_4), or calcium
5 hydride (CaH_2). The first compartment is in communication with a
6 fuel cell. A second compartment contains water and is separated
7 from the first compartment by a porous membrane which permits
8 water vapor to enter the first compartment and react with the
9 metal hydride therein to produce hydrogen (H_2). The Taschek
10 device further includes a third compartment for retaining a
11 reservoir of water. The third compartment is in communication
12 with the second compartment.

13 When the fuel cell requires an influx of hydrogen, the
14 pressure in the first compartment and second compartment, which
15 are substantially equal, decrease, more so in the first
16 compartment than in the second. The decrease in pressure in the
17 second compartment flows water from the third compartment into the
18 second compartment to raise the water level in the second
19 compartment. As more water is exposed to the porous membrane,
20 more water vapor diffuses into the first compartment to increase
21 the hydride reaction and, thereby, the flow of hydrogen to the
22 fuel cell.

23 When the fuel cell no longer requires hydrogen, the pressures
24 in the first and second compartments increase, forcing water out
25 of the second compartment and shutting off diffusion of water

1 vapor into the first compartment, thereby closing down the
2 production of hydrogen.

3 It has been found that there is a delay between hydrogen
4 demand and hydrogen production, which results in excess production
5 for a period of time until pressure and water level stabilize at
6 the increased rate. It has further been found that when hydrogen
7 demand stops, and water leaves the second compartment, hydrogen
8 production decreases promptly to a relatively low rate, but only
9 slowly reduces thereafter until production is essentially stopped.

10 There is thus a need for a hydrogen generating device of the
11 general type disclosed in Taschek, but of simpler configuration,
12 and exhibiting more finely tuned responses to fuel cell demands
13 for more hydrogen, or less, or no hydrogen.

14

15 SUMMARY OF THE INVENTION

16 An object of the invention is, therefore, to provide a
17 hydrogen fuel source for fuel cells and other hydrogen consuming
18 devices, of simple design and which is more reliable in providing
19 prompt and accurate responses to the hydrogen needs of such
20 hydrogen consuming cells and devices.

21 With the above and other objects in view, as will hereinafter
22 appear, a feature of the present invention is the provision of a
23 hydrogen fuel source comprising a first chamber, a second chamber,
24 a hydrogen-containing material disposed in the first chamber, and
25 a reactant disposed in the second chamber, the reactant being

1 adapted to react with the hydrogen-containing material to cause
2 release of hydrogen. A discharge conduit extends from the first
3 chamber for release of hydrogen from the first chamber. A
4 transfer conduit interconnects the first and second chambers for
5 flowing the reactant from the second chamber to the first chamber.
6 A check valve is mounted in the transfer conduit and is adapted to
7 open upon decrease in pressure in the first chamber from a
8 selected pressure and is adapted to close upon the pressure in the
9 first chamber rising to the selected pressure. A pressurizer acts
10 upon the reactant in the second chamber to maintain the reactant
11 at the selected pressure. Thus, upon opening of the check valve,
12 the reactant in the second chamber is urged by the pressurizer to
13 flow through the transfer conduit into the first chamber to react
14 with the hydrogen-containing material to release hydrogen until
15 the selected pressure in the first chamber is restored, thereby to
16 close the check valve and to stop the flow of reactant material
17 into the first chamber.

18 The above and other features of the invention, including
19 various novel details of construction and combinations of parts,
20 will now be more particularly described with reference to the
21 accompanying drawings and pointed out in the claims. It will be
22 understood that the particular devices embodying the invention are
23 shown by way of illustration only and not as limitations of the
24 invention. The principles and features of this invention may be

1 employed in various and numerous embodiments without departing
2 from the scope of the invention.

3

4 BRIEF DESCRIPTION OF THE DRAWINGS

5 Reference is made to the accompanying drawings in which is
6 shown an illustrative embodiment of the invention, from which its
7 novel features and advantages will be apparent.

8 In the drawings:

9 FIG. 1 is a diagrammatic sectional view of one form of a
10 hydrogen source device illustrative of an embodiment of the
11 invention;

12 FIG. 2 is a perspective view of a hydrogen-containing
13 material suitable for use in the device of FIG. 1;

14 FIG. 3 is a diagrammatic sectional illustration of an
15 alternative embodiment of hydrogen source device;

16 FIG. 4 is a diagrammatic sectional view of another
17 alternative embodiment of hydrogen source device;

18 FIG. 5 is an exploded perspective view of a hydrogen-
19 containing material portion of the device of FIG. 4;

20 FIG. 6 is a perspective and broken away view of an
21 alternative hydrogen-containing material portion; and

22 FIG. 7 is a sectional view of the hydrogen-containing
23 material portion of FIG. 6, taken along line VII-VII of FIG. 6.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the FIG. 1, it will be seen that the illustrative hydrogen source device includes a housing 10 with a wall 12 therein, dividing the housing into first and second chambers 14, 16.

The first chamber 14 contains a hydrogen-containing material 18, such as a metal hydride. The metal hydride may be selected from a group of hydrides including lithium hydride, lithium aluminum hydride, calcium hydride, sodium hydride, magnesium hydride, Group IA metal hydrides, and Group IIA metal hydrides. Alternatively, the hydrogen containing material may comprise aluminum foil coated with a polymer bonded hydride composite, or may comprise a polymer-bonded light metal hydride and aluminum in powder form. The first chamber 14 is provided with a discharge conduit 20 extending from the first chamber for release of hydrogen gas from the first chamber. The conduit 20 may extend to a hydrogen consuming device (not shown), such as a fuel cell.

The second chamber 16 houses a reactant 22 adapted to react with the hydrogen-containing material 18 to cause release of hydrogen. The reactant 22 may be selected from a group of reactants including water, sodium borohydride in solution with sodium hydroxide, and a slurry or light metal hydroxide in oil, or in a caustic solution or suspension.

In a further alternative arrangement, the hydrogen containing material may comprise hydrogel and the reactant a lithium hydride

1 slurry. In still another alternative arrangement, the hydrogen-
2 containing material may comprise a polymeric hydrogel and the
3 reactant a lithium hydride slurry in oil.

4 In a still further alternative embodiment, illustrated in
5 FIG. 2, the hydrogen containing material 18 may comprise a
6 selected one of the aforementioned metal hydrides 18a disposed in
7 a wound ribbon 18b of glass cloth, "jelly roll" fashion. The
8 glass cloth 18b serves as a wicking material which transports the
9 reactant 22 to the interior of the mass of metal hydride 18a.

10 A bladder 24 is disposed in the second chamber 16 and the
11 reactant 22 is disposed in the bladder. A transfer conduit 26
12 interconnects the first and second chambers 14, 16 and, more
13 specifically, extends from the bladder 24, through wall 12, and
14 into the first chamber 14 for flowing the reactant 22 from the
15 bladder 24 to the first chamber 14. A check valve 28 is disposed
16 in the transfer conduit 26. The check valve 28 is adapted to open
17 upon decrease in pressure in the first chamber 14 from a selected
18 pressure, and is adapted to close upon the pressure in the first
19 chamber rising to the selected pressure.

20 A pressurizer 30, which may be a coil spring, is mounted in
21 the second chamber 16 and is adapted to apply pressure to the
22 bladder 24, and thereby the reactant 22, to maintain the reactant
23 at a selected pressure.

24 In operation, when the hydrogen consuming device requires
25 additional hydrogen, a valve 32 in the conduit 20 opens,

1 permitting hydrogen to flow from the first chamber 14, through the
2 conduit 20, to the hydrogen consuming device. The flow of
3 hydrogen from the first chamber 14 reduces the pressure in the
4 first chamber to a level below a selected pressure, typically
5 about 50 p.s.i., causing the check valve 28 to open.

6 The reactant 22 in the bladder 24 is maintained at 50 p.s.i.,
7 or other selected pressure, by the spring 30. Thus, opening of
8 the valve 28 causes reactant 22 to flow through the transfer
9 conduit 26 to the first chamber 14, where the reactant 22 reacts
10 with the hydrogen-containing material 18, to effect release of
11 hydrogen in the first chamber 14 and flow of hydrogen therefrom
12 through the discharge conduit 20.

13 When the hydrogen consuming device has received sufficient
14 hydrogen, flow stops in the discharge conduit 20 and the pressure
15 in the first chamber 14 quickly attains 50 p.s.i., causing the
16 check valve 28 to close, immediately stopping admittance of
17 reactant 22 to the first chamber 14. The spring 30 acts to
18 maintain the 50 p.s.i. selected pressure on the bladder 24 and on
19 the check valve 28. As soon as pressure in the first chamber 14
20 drops below 50 p.s.i., the check valve opens and another cycle of
21 hydrogen generation commences. The cycles are repeated until the
22 bladder 24 is exhausted of reactant material. At that point, the
23 housing 10 may be disconnected from communication with the
24 hydrogen-consuming device and discarded and replaced with a
25 similar hydrogen source device.

1 In FIG. 3, there is shown diagrammatically an alternative
2 embodiment in which the second chamber 16 retains the reactant 22
3 without a bladder, and the pressurizer 30 comprises gas 30a under
4 pressure, rather than a spring.

5 The operation of the device shown diagrammatically in FIG. 3
6 is essentially the same as operation of the device shown in FIG.
7 1. The reactant 22 is maintained at 50 p.s.i., or other selected
8 pressure, by the gas 30a. Opening of the check valve 28,
9 triggered by a pressure drop in the chamber 14, causes reactant to
10 flow through the transfer conduit 26 to the first chamber 14,
11 where the reactant 22 reacts with the hydrogen-containing material
12 18, to effect release of hydrogen in the first chamber 14.

13 When hydrogen is no longer required by the hydrogen-consuming
14 device, pressure in the first chamber 14 returns to 50 p.s.i.,
15 causing the check valve 28 to close. The gas 30a in the chamber
16 16 maintains the 50 p.s.i. pressure on the check valve 28. As
17 soon as pressure in the first chamber 14 drops below 50 p.s.i.,
18 the check valve opens and another cycle of hydrogen generation
19 begins.

20 It will be apparent that the device illustrated
21 diagrammatically in FIG. 3 can be configured similarly to the
22 device shown in FIG. 1, that is, with both chambers 14, 16
23 disposed in a single housing 10 and separated by a wall 12.

24 In FIGS. 4 and 5, there is shown another alternative
25 embodiment in which the hydrogen-containing material 18 comprises

1 a selected number of round flat discs 36 of hydride material.
2 Each disc 36 is provided with rigid outer separator coverings 34,
3 on the flat surfaces of the disc, which coverings preferably are
4 of steel or Teflon, and a central orifice 38 extending
5 therethrough. Embedded in each disc 36 and in communication with
6 the orifice 38 is a spirally-wound sparging tube 40 having therein
7 a series of holes 42. The discs 36 are stacked, one on another,
8 in the first chamber 14 on a substantially rigid transfer conduit
9 44 in communication with the valve 28.

10 In the embodiment shown in FIG. 4, the second chamber 16 is
11 provided with the gas pressurizer 30a, described hereinabove, and
12 a gas charging valve 46. At the discharge conduit 20, the first
13 chamber 14 is provided with a filter 48, such as a charcoal
14 filter, to remove traces of hydrocarbons.

15 Referring to FIG. 4, it will be seen that the housing 10 is
16 in two parts, a first part 10a for retaining the hydrogen-
17 containing material 18, and a second part 10b for retaining the
18 reactant 22, such as water. Similarly, the aforementioned wall 12
19 comprises a first wall 12a constituting an end wall of the housing
20 first part 10a, and a second wall 12b constituting an end wall of
21 the housing second part 10b.

22 Still referring to FIG. 4, it will be seen that the device
23 includes a hub portion 50 in which is mounted the check valve 28.
24 The hub portion 50 includes a first internally threaded projection
25 52 and a second internally threaded projection 54. The housing

1 first part 10a is provided with a first externally threaded
2 projection 56 adjacent the wall 12a and adapted to threadedly
3 engage the hub first projection 52. Similarly, the housing second
4 part 10b is provided with a second externally threaded projection
5 58 adjacent the wall 12b and adapted to threadedly engage the hub
6 second projection 54. Thus, the housing first and second parts
7 10a, 10b are readily disengageable from one another, such that,
8 for example, the housing first part 10a may be removed and
9 replaced repeatedly. The housing second part 10b can be re-
10 charged through the charging valve 46. However, if recharging is
11 not in the offing, the second housing 10b may also be easily
12 replaced. To facilitate such interchange of housing components of
13 the device, the hub portion 50 is provided with an on/off actuator
14 60 for positively closing off the valve 28 during such
15 interchanging operations.

16 The operation of the device of FIG. 4 is very similar to that
17 of the previously described devices. Opening of the check valve
18 28, initiated by a pressure drop in the first chamber 14, causes
19 reactant 22 to flow through the valve 28 and transfer conduit 44
20 to the first chamber, where the reactant flows through the
21 transfer conduit and into the sparging tubes 40 and, thence, into
22 the hydrogen-containing material of each of the discs 36. The
23 reactant 22 reacts with the hydrogen-containing material 18 to
24 effect release of hydrogen in the first chamber 14. The released
25 hydrogen flows between the disc perimeters 62 and the housing side

1 walls 64, through the filter 48, and exits through the discharge
2 conduit 20 and the valve 32.

3 In FIGS. 6 and 7 there is shown an alternative disc 70 in
4 which there is substituted for the sparging tube 40, a sparging
5 diskette 72 comprising two wafers 74, of steel or the like,
6 slightly spaced apart and welded together at their peripheries.
7 The wafers 74 are each provided with holes 76 for passage of water
8 from the diskette 72 into the disc 70 of hydrogen-containing
9 material 18.

10 In the FIG. 4 embodiment, using the discs 36, 70 of either
11 FIG. 4 or FIG. 6, the reactant 22 is substantially evenly
12 distributed through the hydrogen-containing material 18.

13 There are thus provided hydrogen generating devices of simple
14 configuration and exhibiting finely tuned responses to demands of
15 a hydrogen consuming device.

16 It is to be understood that the present invention is by no
17 means limited to the particular construction herein disclosed
18 and/or shown in the drawing, but also comprises any modification
19 or equivalent within the scope of the claims.

What is claimed is:

1. A hydrogen containing unit for disposition in a hydrogen fuel source device, the device having a first chamber for housing hydrogen-containing material, a second chamber for housing a liquid reactant adapted to react with the hydrogen-containing material to release hydrogen therefrom, and structure for facilitating flow of the reactant from the second chamber to the first chamber, the hydrogen-containing material comprising:

a wick comprising a coiled ribbon of liquid transporting material; and

a layer of a hydrogen-containing material disposed on said ribbon and coiled therewith;

wherein liquid reactant contacting said wick is transported by said wick into interior portions of said first chamber to reach interior portions of said hydrogen-containing material.

2. The hydrogen containing unit in accordance with claim 1 wherein said liquid transporting material comprises glass cloth.

3. The hydrogen containing unit in accordance with claim 1 wherein said hydrogen-containing material is a metal hydride.

4. The hydrogen containing unit in accordance with claim 2 wherein said hydrogen-containing material is a metal hydride.

5. A hydrogen fuel source comprising:

a first chamber;

a second chamber;

a hydrogen-containing material disposed in said first chamber;

a reactant disposed in said second chamber, the reactant being adapted to react with the hydrogen-containing material to cause release of hydrogen;

a discharge conduit extending from said first chamber for release of hydrogen from said first chamber;

a transfer conduit interconnecting said first and second chambers for flowing the reactant from said second chamber to said first chamber;

a check valve mounted in said transfer conduit and adapted to open upon decrease in pressure in said first chamber from a selected pressure and adapted to close upon the pressure in said first chamber rising to the selected pressure;

a pressurizer acting upon said reactant in said second chamber to maintain said reactant at the selected pressure;

wherein upon opening of said check valve the reactant in said second chamber is urged by said pressurizer to flow through said transfer conduit into said first chamber to react with the hydrogen-containing material to release hydrogen until the selected pressure in said first chamber is restored, thereby to close said check valve and to stop the flow of reactant material into said first chamber; and

wherein said hydrogen-containing material comprises at least one disc of said material, said disc having a central orifice therethrough, and a sparging tube embedded therein and in communication with said central orifice, said sparging tube being provided with a plurality of

holes, such that reactant admitted to said central orifice flows through said sparging tube and said sparging tube holes to said hydrogen-containing material.

6. A hydrogen containing unit for disposition in a hydrogen fuel source device, the device having a first chamber for housing hydrogen-containing material, a second chamber for housing a liquid reactant adapted to react with the hydrogen-containing material to release hydrogen therefrom, and structure for facilitating flow of the reactant from the second chamber to the first chamber, the hydrogen-containing unit comprising:

a disc of hydrogen-containing material, said disc defining a central orifice therethrough; and

a reactant distribution structure embedded in said disc and in communication with the central orifice;

wherein liquid reactant flowed into the central orifice further flows into said distribution structure for distribution throughout said disc.

7. The hydrogen-containing unit in accordance with claim 6 wherein said reactant distribution structure comprises a tube having holes therein.

8. The hydrogen-containing unit in accordance with claim 6 wherein said reactant distribution structure comprises a hollow diskette having holes therein.

9. A hydrogen fuel source comprising:

a first housing defining a first chamber;

a first connector disposed on said first housing;

a second housing defining a second chamber;

a second connector disposed on said second housing;

a hydrogen-containing material disposed in the first chamber;

a reactant disposed in the second chamber, the reactant being adapted to react with the hydrogen-containing material to cause release of hydrogen;

a discharge conduit extending from said first chamber for release of hydrogen from said first chamber;

a hub member having therein a transfer conduit for communication between the first and second chambers, and a check valve in the transfer conduit, said hub member further having first and second connectors thereon;

wherein said first housing first connector is releasably attachable to said hub member first connector, and said second housing second connector is releasably attachable to said hub member second connector;

whereby said first and second housings are connectable to and disconnectable from said hub member.

10. The hydrogen fuel source in accordance with claim 9 and further comprising an on/off actuator mounted on said hub member and operative to open and close said check valve.

11. The hydrogen fuel source in accordance with claim 9 wherein said hydrogen-containing material comprises:

a disc of hydrogen-containing material, said disc having a central orifice therethrough; and

a reactant distribution structure embedded in said disc and in communication with the central orifice;

wherein liquid reactant flowed into the central orifice further flows into said distribution structure for distribution throughout said disc.

12. The hydrogen fuel source in accordance with claim 11 wherein said reactant distribution structure comprises a tube having holes therein.

13. The hydrogen fuel source in accordance with claim 11 wherein said reactant distribution structure comprises a hollow diskette having holes therein.

14. The hydrogen-containing unit in accordance with claim 6 wherein said unit further comprises rigid separator coverings disposed on flat surfaces of said disc.

15. The hydrogen-containing unit in accordance with claim 14 wherein said separator coverings are a selected one of steel and teflon.

16. The hydrogen-containing unit in accordance with claim 8 wherein said diskette comprises first and second steel plates joined together at their peripheries but otherwise spaced from each other to form an internal compartment in communication with said hydrogen-containing material by way of said holes.

17. The hydrogen fuel source in accordance with claim 9 wherein said connectors are threaded for threaded interconnection between said hub member and said first housing, and between said hub member and said second housing.

18. A hydrogen fuel source comprising:

a first chamber disposed in a first housing;

a second chamber disposed in a second housing;

a hydrogen-containing material disposed in said first chamber;

a reactant disposed in said second chamber, the reactant being adapted to react with the hydrogen-containing material to cause release of hydrogen;

a discharge conduit extending from said first chamber for release of hydrogen from said first chamber;

a transfer conduit interconnecting said first and second chambers for flowing the reactant from said second chamber to said first chamber;

a check valve mounted in said transfer conduit and adapted to open upon decrease in pressure in said first chamber from a selected pressure and adapted to close upon the pressure in said first chamber rising to the selected pressure;

a pressurizer disposed in said second housing for acting upon said reactant in said second chamber to maintain said reactant at the selected pressure;

wherein upon opening of said check valve the reactant in said second chamber is urged by said pressurizer to flow through said transfer conduit into said first chamber to react with the hydrogen-containing material to release hydrogen until the selected pressure in said first chamber is restored, thereby to close said check valve and to stop the flow of reactant material into said first chamber;

wherein said pressurizer is a gas under pressure in said second housing and acting on said second chamber and thereby said reactant, and

wherein said second housing is provided with a gas charging valve for flowing gas into said second housing to bear upon said second chamber to establish the selected pressure.

19. The hydrogen fuel source in accordance with claim 12 wherein said tube is coiled in said disc.

20. A hydrogen fuel source comprising:

a first chamber;

a second chamber;

a hydrogen-containing material disposed in said first chamber;

a reactant disposed in said second chamber, the reactant being adapted to react with the hydrogen-containing material to cause release of hydrogen;

a discharge conduit extending from said first chamber for release of hydrogen from said first chamber;

a transfer conduit interconnecting said first and second chambers for flowing the reactant from said second chamber to said first chamber;

a check valve mounted in said transfer conduit and adapted to open upon decrease in pressure in said first chamber from a selected pressure and adapted to close upon the pressure in said first chamber rising to the selected pressure;

a pressurizer acting upon said reactant in said second chamber to maintain said reactant at the selected pressure;

wherein upon opening of said check valve the reactant in said second chamber is urged by said pressurizer to flow through said transfer conduit into said first chamber to react with the hydrogen-containing material to release hydrogen until the selected pressure in said first chamber is restored, thereby to close said check

valve and to stop the flow of reactant material into said first chamber;

wherein said hydrogen-containing material comprises a metal hydride; and

wherein said metal hydride comprises a metal hydride selected from a group of metal hydrides consisting of lithium hydride, lithium aluminum hydride, calcium hydride, sodium hydride, magnesium hydride, Group 1A metal hydrides, borohydrides of Group 1A metals, and Group 11A metal hydrides.

21. The hydrogen fuel source in accordance with claim 9 wherein said hydrogen-containing material comprises a plurality of discs of hydrogen-containing material, said discs each having an orifice therethrough and a reactant distribution structure embedded in said disc and in communication with said orifice, said orifice being adapted for communication with a distribution structure in at least one other of said discs, and in communication with a common duct.

22. The hydrogen fuel source in accordance with claim 11 wherein said reactant distribution structure comprises at least one tube having holes therein, and extending from said orifice.

1 A DISPOSABLE HYDROGEN FUEL SOURCE

2

3 ABSTRACT OF THE DISCLOSURE

4 A disposable hydrogen fuel source includes first and second
5 chambers, a hydrogen-containing material disposed in the first
6 chamber and a reactant disposed in the second chamber, the
7 reactant being adapted to react with the hydrogen-containing
8 material to cause release of hydrogen. A discharge conduit
9 extends from the first chamber for release of hydrogen therefrom.
10 A transfer conduit interconnects the first and second chambers for
11 flowing the reactant from the second chamber to the first chamber,
12 and a check valve is mounted on the transfer conduit and is
13 adapted to open upon decrease in pressure in the first chamber
14 from a selected pressure and is adapted to close upon the pressure
15 in the first chamber rising to the selected pressure. A
16 pressurizer acts upon the reactant in the second chamber to
17 maintain the reactant at the selected pressure. Upon opening of
18 the check valve, the reactant in the second chamber is urged by
19 the pressurizer to flow through the transfer conduit into the
20 first chamber to react with the hydrogen-containing material to
21 release hydrogen until the selected pressure in the first chamber
22 is restored, thereby to close the check valve and to stop the flow
23 of reactant material into the first chamber.

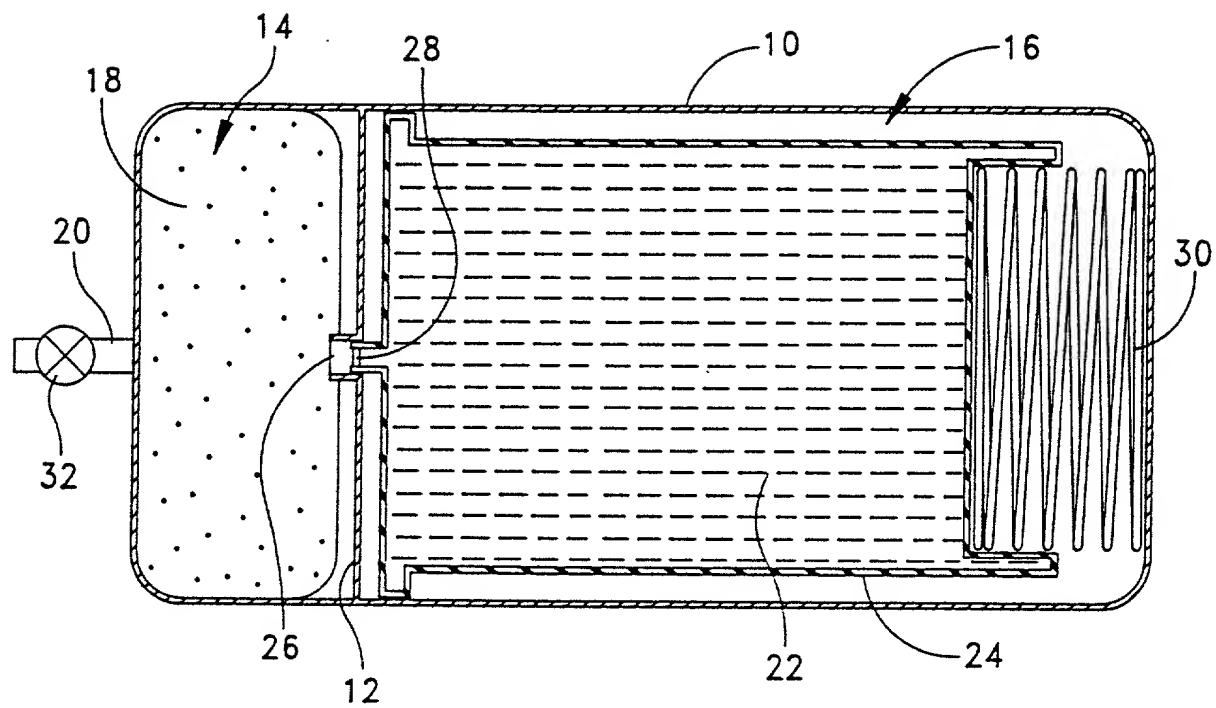


FIG. 1

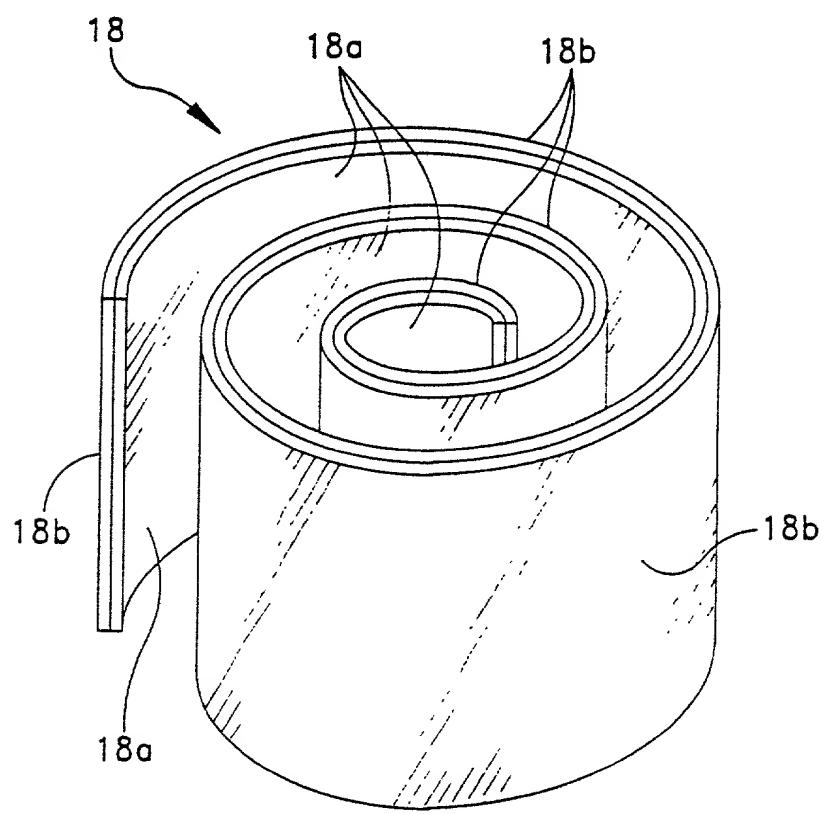


FIG. 2

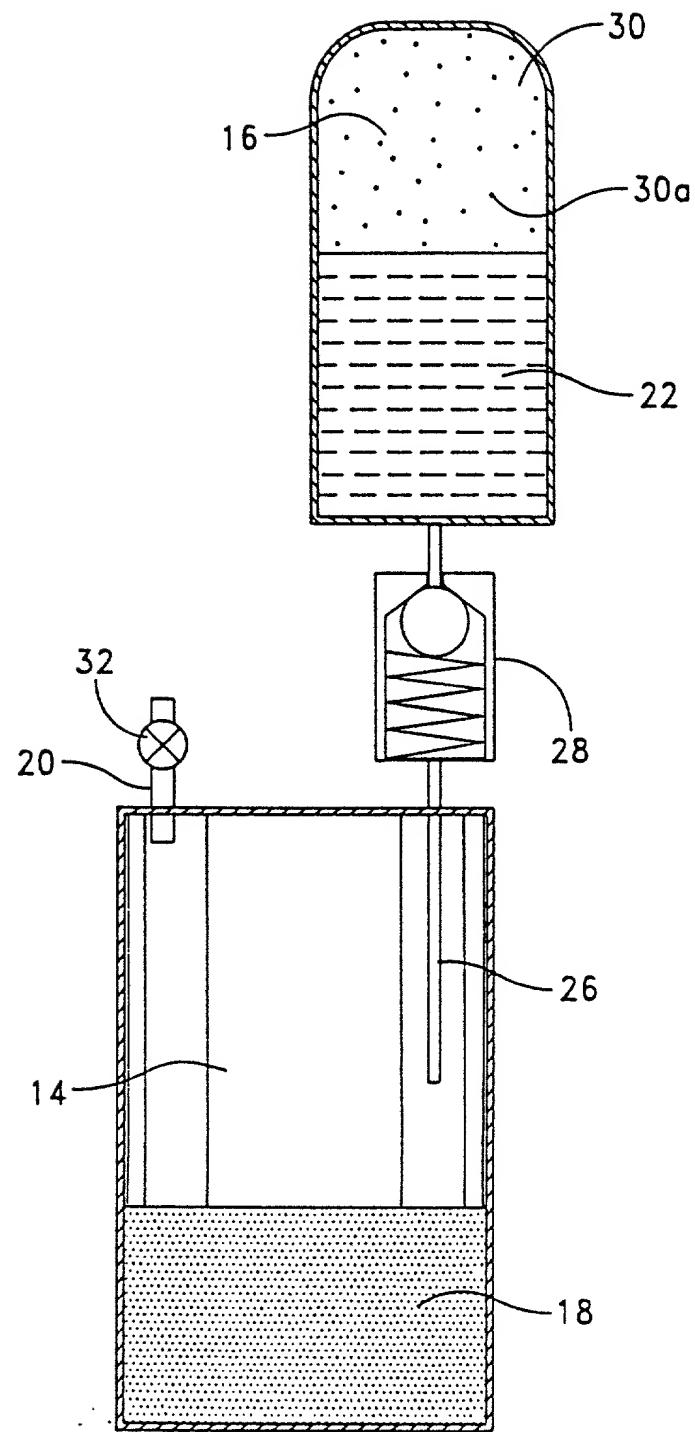


FIG. 3

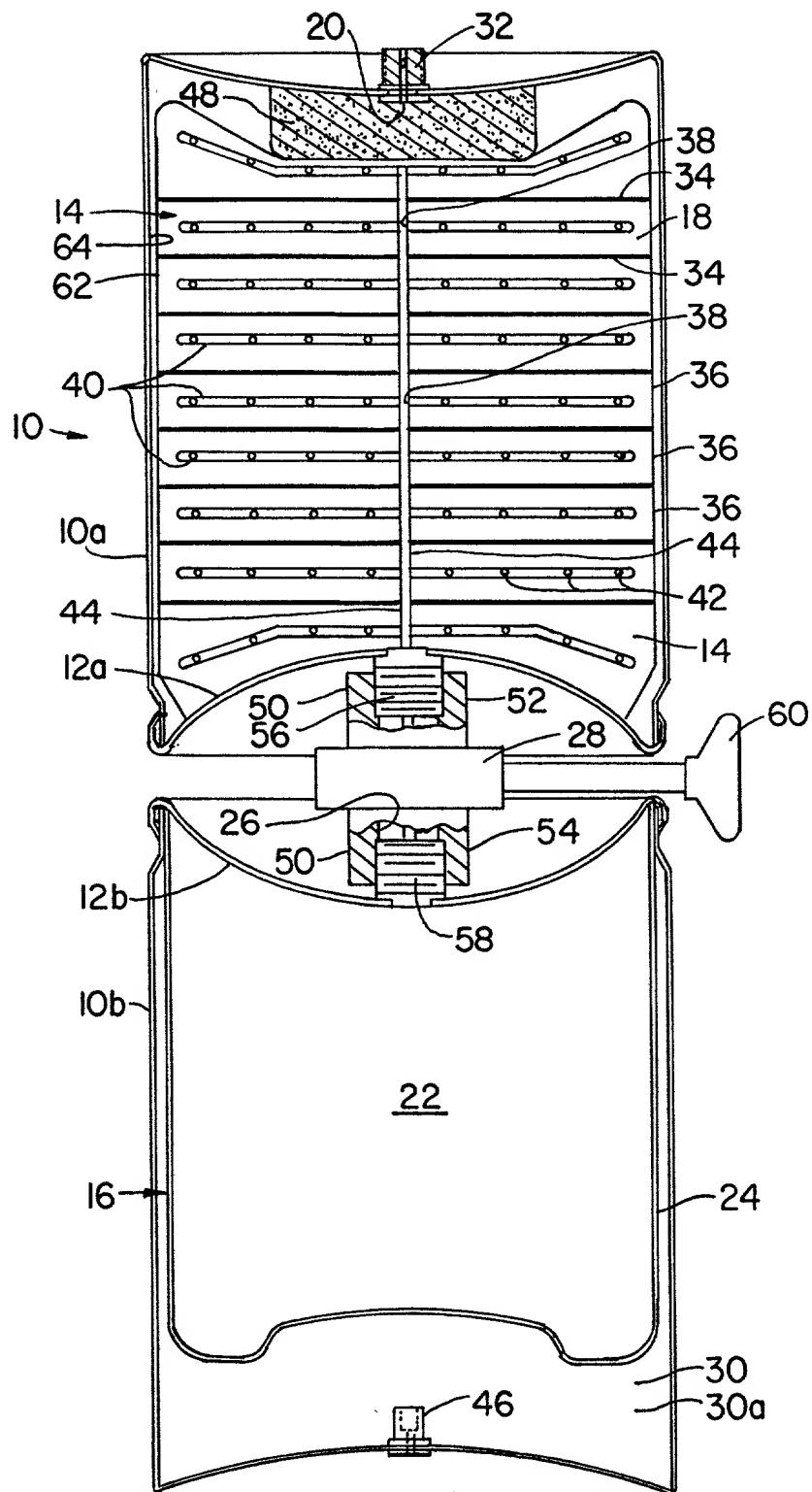


FIG. 4

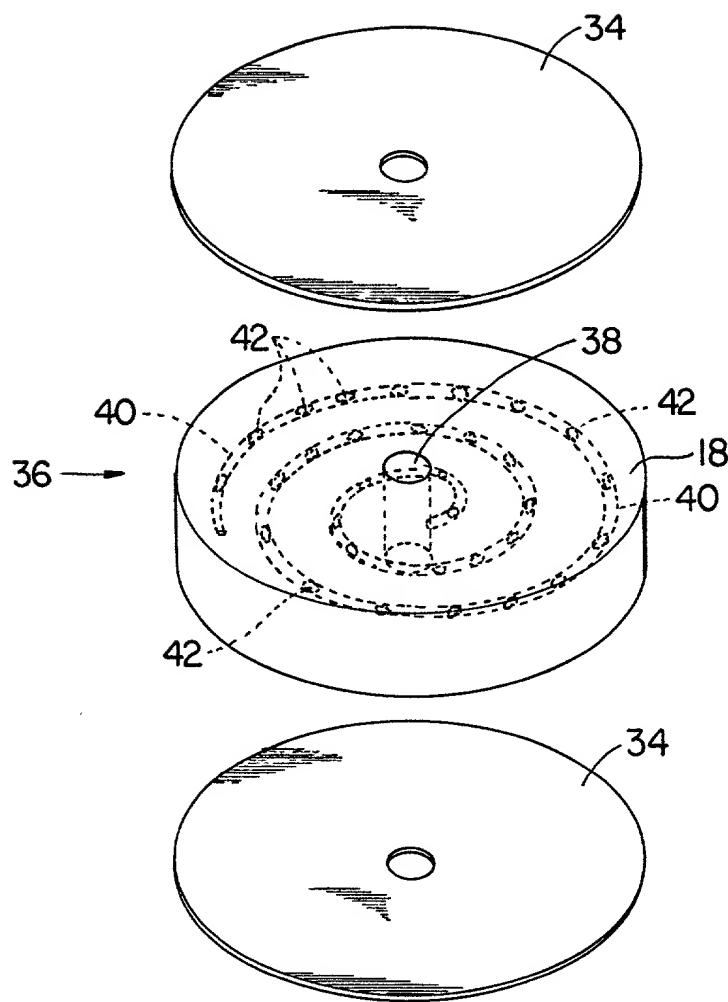


FIG. 5

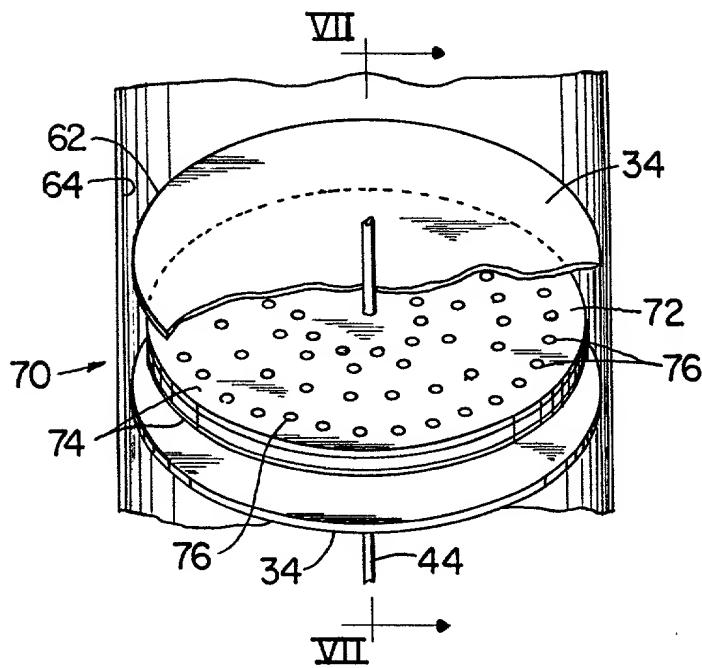


FIG. 6

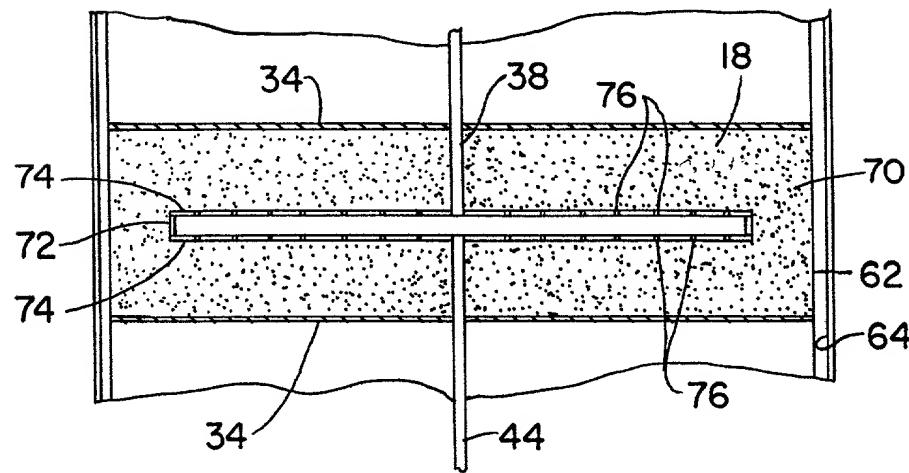


FIG. 7

DECLARATION AND POWER OF ATTORNEY

As a below-named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled "A DISPOSABLE HYDROGEN FUEL SOURCE", the specification of which is attached hereto.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, Section 1.56(a).

I hereby appoint Pandiscio & Pandiscio, a firm composed of Nicholas A. Pandiscio, Registration No. 17293, Mark J. Pandiscio, Registration No. 30883, Scott R. Foster, Registration No. 20570, and William A Bonk, III, Registration No. 40,521, or any of them, of 470 Totten Pond Road, Waltham, Massachusetts 02451-1914, (Telephone No. 781-290-0060), my attorneys with full power of substitution and revocation, to prosecute this application and to transact all business in the U.S. Patent and Trademark Office connected therewith.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or

imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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DORINE M. CORMIER, Notary Pub.
My Commission Expires August 14, 2000